2013 Maryland FMP Report (July 2014)
Section 12. Horseshoe Crab (*Limulus polyphemus*)

Chesapeake Bay FMP

Horseshoe crabs and migratory shorebirds, particularly the red knot (*Calidris canutus rufa*), have a unique ecological relationship. Red knot rely on horseshoe crab eggs as food during their spring migration to their Arctic breeding grounds. In September, 2013, the U.S. Fish and Wildlife Service (USFWS) published a proposed rule in the Federal Register to list the red knot (*Calidris canutus rufa*) as a threatened species.[1] The USFWS identified climate change induced effects such as habitat impairment and loss, asynchronous timing with food resources, and predation as principal threats. The USFWS expressed confidence that the Atlantic States Marine Fisheries Commission's (ASMFC) adaptive resource management (ARM) framework would ensure sufficient egg abundance to meet red knot and horseshoe crab needs.[1]

The Chesapeake Bay and Atlantic Coast Horseshoe Crab Fishery Management Plan (CBFMP) was adopted in 1994. The CBFMP prohibited the harvest of horseshoe crabs during the spawning season as a conservation measure for protecting their eggs and providing an important food resource for shorebirds. The plan established a spawning stock census of horseshoe crabs, stricter harvest reporting standards, and a program to delineate important spawning areas. The CBFMP was reviewed in 2011. The review team recommended amending the plan to address two issues: 1) adopt the ASMFC's ARM framework and 2) address the lack of genetic and spawning data for horseshoe crabs within Chesapeake Bay.

In 1998, the ASMFC adopted the Interstate Fishery Management Plan for Horseshoe Crabs. Since then, there have been a number of changes. Addendum I (2000) to the Interstate Fishery Management Plan for Horseshoe Crab established state-by-state quotas on horseshoe crab landings that were 25% below reference period landings. Addendum II (2001) allowed quota transfer between states. Addendum III (2004) further reduced commercial harvest and added seasonal closures in New Jersey, Delaware, and Maryland. These additional restrictions were implemented to further increase horseshoe crab egg abundance, a major dietary component for migratory shorebirds including the red knot. The red knot population has decreased since the 1980s and may be affected by horseshoe crab egg abundance.

Addendum IV (2006) instituted seasonal and spatial harvest restrictions in Maryland and Virginia. Harvest restrictions apply only to the bait fishery. In addition, no more than 40% of Virginia's quota can be harvested east of the COLREGS line (determined by the International Regulations for Preventing Collisions at Sea and determine the "rules of the road" followed by vessels at sea). They must also have a minimum male to female ratio of 2:1 if landed in Virginia. Addenda V (2008) and VI (2010) continued the Addendum IV restrictions for Maryland and Virginia. Addendum VII (2012) implemented the ARM framework in 2013 to optimize horseshoe crab harvest while conserving both shorebird and horseshoe crab abundance.

Stock Status

Horseshoe crabs caught in Maryland waters include individuals from three separate spawning stocks: Maryland, Virginia, and Delaware Bay.[2] Juvenile and adult male indices from the Delaware Bay region show evidence of population recovery [2] There is no detectable abundance trend for adult females. Increased stock biomass has been attributed to harvest closures and decreased fishing mortality. Horseshoe crab abundance has been in decline since 2009 in the New York region and since 2004 in the New England region.[3] These declines may indicate a northward shift in harvest pressure.[3]

Egg density on Delaware Bay beaches has varied over the years. There was a significant increase starting in 2005 with a 3-fold increase from 2009 to 2010 (42,400 eggs/m^2 to 136,000 eggs/m^2, respectively).[4,5] Since then, egg density has been decreasing. Egg density in 2012 (35,000 eggs/m^2) was comparable to that measured in the mid-2000s.[3] Peak egg density generally coincides with peak shorebird migration.

Reported biomedical mortality from harvest to release was 1.3% in 2012. However, a 15% rate for bleeding and release mortality was assumed and used in the stock assessment. In 2011, a mortality range of 5-30% was included in the ARM assessment. Estimated annual mortality averaged 70,567 crabs from 2007 – 2012.[3]

A coastwide horseshoe crab stock assessment update was completed in 2013. To date, no overfishing, overfished, or depleted definitions and reference points have been developed.[3]

Current Management Measures

Maryland's 2013 commercial quota was 255,980 male horseshoe crabs and the 2014 quota will be 255,000 male horseshoe crabs. Quota overages are deducted from the following year's quota. Horseshoe crab harvest was prohibited from December 1 to June 7. From June 8 to July 12, horseshoe crab harvest was restricted to waters beyond 1 mile of Maryland's Atlantic coast. Harvest was limited to 100 crabs per person per day for harvesters possessing a horseshoe crab permit. Permitted harvesters were allowed to catch their daily limit (indicated on their permit) from July 15th to August 8th. Harvest was later changed to 150 crabs per person per day from August 9th to the end of the season (November 30th). Non-permitted harvest was delayed from July 1st to 13th, but the landing limit remained 25 crabs per person per day. Horseshoe crab harvest was allowed in all tidal waters of Maryland from July 13 to November 30. Harvesters without a horseshoe crab permit are limited to

25 crabs per person per day. All horseshoe crab harvest is limited to Monday through Friday. Harvest of female horseshoe crabs is prohibited. Permitted harvesters report landings weekly; non-permitted harvesters report landings monthly.

Horseshoe crab bycatch mortality is assumed to be low based on observations from the fishery. However, a large number of horseshoe crabs are impinged annually at the water intakes for Calvert Cliffs Nuclear Power Plant.[6] Prior to the 2012 spawn, a horseshoe crab barrier was installed at the water intakes. Impingement was reduced from 1,755 horseshoe crabs in 2011 down to 430 in 2012. Impingement results for 2013 were similar to those for 2012.

Three companies received scientific collection permits for the collection of horseshoe crab blood. The permit allows collection during seasonal closures. Limulus Amebocyte Lysate (LAL), extracted from horseshoe crab blood, is used to screen injectable drugs, biologics, medical devices, and raw materials for presence of endotoxins and gram-negative bacteria. All crabs harvested for bleeding must be returned to the waters where they were caught within 48 hours. Crabs purchased from bait harvesters must be returned to the bait harvester after being bled. A chain of custody form must accompany all batches of horseshoe crabs.

The ARM analysis revealed two circumstances that affect red knot demography and annual survival: 1) horseshoe crab abundance and red knot body mass at departure from Delaware Bay, and 2) arctic snow conditions upon arrival at the breeding grounds. The ARM workgroup developed five horseshoe crab management alternatives:[7] 1) a full harvest moratorium on both sexes; 2) a harvest limit of 250,000 males and 0 females; 3) a harvest limit of 500,000 males and 0 females; 4) a harvest limit of 280,000 males and 140,000 females; and 5) a harvest limit of 420,000 males and 210,000 females. An adaptive management approach is being used to identify which alternative to implement. Alternative #4 is currently in place.

The U.S. Fish and Wildlife Service coordinates a coast-wide tagging program. Biomedical, conservation outreach, and research entities tag horseshoe crabs annually. Over 226,000 crabs have been tagged with a recapture rate of 11%.The ASMFC Horseshoe Crab Technical Committee developed tagging program guidelines to make data collected more applicable to management issues.

The Fisheries

Maryland's commercial horseshoe crab harvest is caught primarily by trawl nets in the Atlantic Ocean. The harvest quota increased to 255,980 for 2013. Previously the quota had been 170,000 horseshoe crabs (2004-2012). Landings in 2013 were 240,688 horseshoe crabs or 94% of the Maryland quota (Figure 1). Maryland commercial landings have been either at or below the quota since 1998 except for an overage of 1,464 crabs in 2007.

ASMFC's horseshoe crab Plan Review Team (PRT) recommended that Virginia implement area-specific quota reductions in 2011 to reduce their quota by at least 21,600 crabs. The reduction compensated for quota overages in 2009 and 2010. Late reporting of additional overages was also a concern.

The number of crabs landed coastwide for biomedical bleeding (not bait) has increased since the mid-2000s. Horseshoe crab mortality in the biomedical sector has exceeded the 57,500 crab threshold each year since 2007 (Figure 2). Due to consistent, annual violation of the mortality threshold, the ASMFC Plan Review Team recommended that the ASMFC Management Board consider actions to decrease biomedical use and mortality of horseshoe crabs.[3]

Issues/Concerns

USFWS published a proposed rule to list the red knot as a threatened species. The primary threats to red knot in the mid-Atlantic region are climate change induced effects such as habitat impairment and loss, and asynchronous timing with food resources. Availability of horseshoe crab eggs, horseshoe crab harvest, and bleeding mortality are of concern. The USFWS recognized the validity of the ARM framework to control horseshoe crab harvest and prevent harvest from being a threat to red knot. A concurrent factor is the presence of peregrine falcons, which prey on red knot. The presence of peregrine falcons can inhibit red knot foraging regardless of horseshoe crab egg abundance.[1] In addition, genetic variability in red knot body mass thresholds may be an important factor for their annual survival. To date, the migratory red knot population has not shown any evidence of recovery despite the four-fold reduction in horseshoe crab harvest.[7]

Continued congressional funding for the Virginia Tech benthic trawl horseshoe crab survey is uncertain.[3,8] Data from this survey is critical for use of the ARM model and stock assessments. The trawl survey is relatively inexpensive ($200,000).[3] The biomedical industry provided partial funding for the 2012 trawl survey. These analyses are necessary to ensure that horseshoe crab spawning stock and egg production are sufficient to support migratory shorebird feeding (esp. red knot).

Reductions in Mid-Atlantic harvest quotas, particularly in Delaware Bay, have redirected harvest to the New York and New England fisheries. Localized overharvest within these regions is possible meaning current harvest levels may not be unsustainable.[8,3]

Regional differences in the level of biomedical harvest and mortality are evident.[3] Research in Massachusetts indicates that biomedical related mortality may be double the 15% level used for management.[8] An increase in estimated biomedical mortality would significantly increase the extent of mortality overages, which have occurred annually since 2007. Demand for LAL has increased during this same time period.

The ASMFC Plan Review Team recommended that the Management Board consider implementation of additional restrictions on the biomedical industry.[3]

The bait industry has been importing three Asian horseshoe crab species to supply the bait market and take advantage of increased bait prices. Two concerns associated with importation of this non-native species are the introduction of non-native parasites and pathogens; and possible human health risks from the neurotoxin tetrodotoxin found in one of the Asian species.[3] ASMFC approved Resolution 13-01 to ban the import and use of the Asian horseshoe crab as bait (http://www.asmfc.org/species/horseshoe-crab) and has encouraged member states to ban importation of Asian horseshoe crabs.[3] Maryland banned the import of Asian horseshoe crabs in 2013.[9]

Calvert Cliffs Nuclear Power Plant (CCNPP) impinges horseshoe crabs in their water intakes. They are now required to report these impingements to MD DNR. In April 2012, CCNPP installed a new horseshoe crab barrier that subsequently reduced the number of impinged horseshoe crabs from 1,755 in 2011 to 430 in 2012.[6] Of those 430 impinged horseshoe crabs, the power plant recorded 322 horseshoe crab mortalities. A comparable number was impinged in 2013.[6]

Figure 1. Maryland's commercial horseshoe crab landings and quota: 1998-2013.[6,10] The 2013 quota is restricted to male horseshoe crabs.

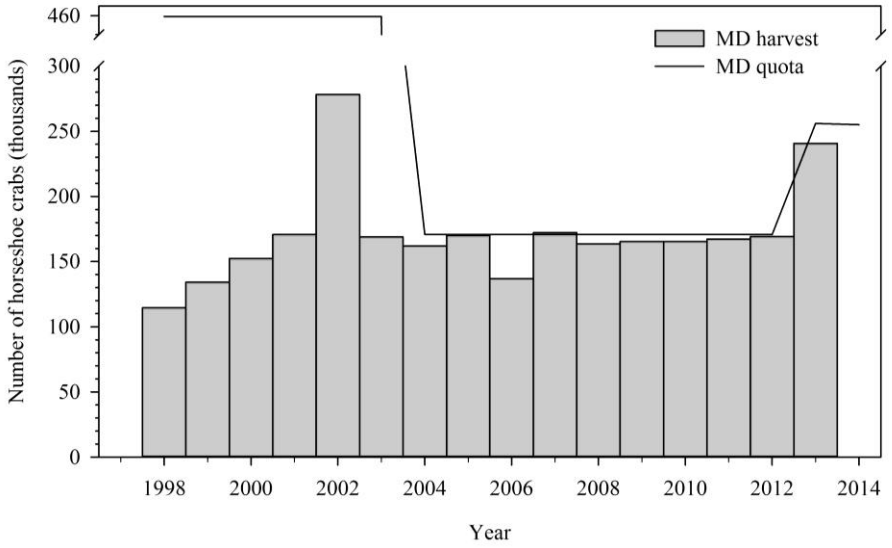


Figure 2. Actual and threshold mortalities of horseshoe crabs bled for the biomedical industry: 2004-2012.[3] The 2013 mortality estimate was not available at the time of this report. Mortality does not include crabs returned to the bait industry.

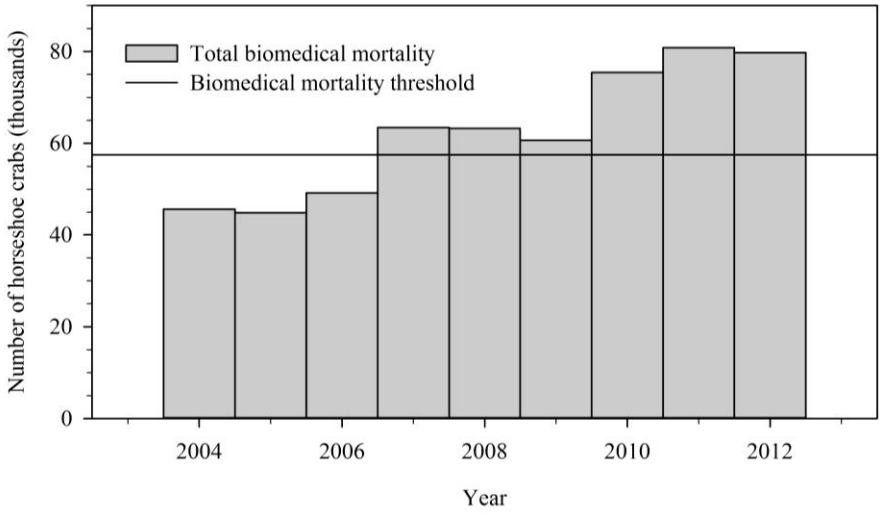
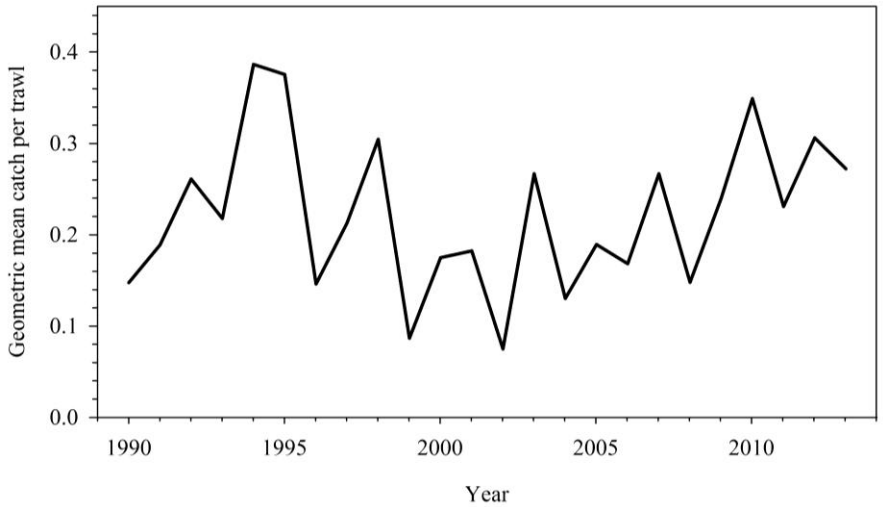


Figure 3. Geometric mean catch of horseshoe crabs per trawl from the Maryland Coastal Bays Trawl Survey: 1990 – 2013.[6]



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[9] Classification of Nonnative Aquatic Organisms. Annotated Code of Maryland § 08.02.19.04 (2013).

[10] Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division. Retrieved from http://www.st.nmfs.noaa.gov/index

1994 Chesapeake Bay and Atlantic Coast Horseshoe Crab Management Plan Implementation Table (updated 3/2014)			
Problem Area	**Action**	**Date**	**Comments**
Strategy 1.1 Maryland and Virginia will protect the ecological role of horseshoe crabs by protecting horseshoe crab spawning areas and monitoring harvest.	1.1 Maryland and Virginia will prohibit the hand collection of horseshoe crabs from beaches during the peak time of shorebird migration, May 1-June 7.	1995	MD prohibited hand collection of HSCs between May 1 and June 7.
		1996	Based on spawning data, MD modified the restriction on hand collection of HSC to between April 1 and June 30 on Monday and Thursday only.
		1998	Since the CBP Horseshoe Crab FMP was adopted in 1994, coastal ASMFC requirements were adopted in 1998. Jurisdictions comply with all ASMFC HSC harvest restrictions.
		2001	NMFS established a HSC reserve in federal waters having a 30 mile radius from the mouth of Delaware Bay.
		2009 Open	MD COMAR 08.02.10.01.01 states that all persons are prohibited from catching or landing HSCs in state waters from December 1 to June 7, and catching or landing HSCs from the Chesapeake Bay and its tidal tributaries, or within 1 mile of the Atlantic coast or its coastal bays shoreline from June 8 to July 12. Persons can collect crabs Monday thru Friday from July 13 to November 30. There are no recreational catch limits but a person must abide by the seasonal closures and the 25 crab/person/day if he/she doesn't have a permit.
		Open	VA Chapter 4 VAC 20-900- restricts hand collection unless a person has a hand harvester license. 5 HSCs/person/day may be harvested for personal use without a license.
		2006	VA prohibits HSC harvest within 1,000 ft of mean low water May 1 through June 7.
		2011	VA implemented a license and permit moratorium. Only commercial fishermen who held a HSC harvest permit prior to May 1, 2011 are eligible to purchase a permit after May 1, 2011.
	1.2a Maryland will prohibit the scraping, trawling or dredging of horseshoe crabs between May 1 and June 7 within the Chesapeake Bay, coastal bay areas, and 1 mile of the Atlantic Coast.	1995	The time period recommended to prohibit the scraping, trawling, and dredging of HSCs within the Chesapeake Bay, Coastal Bays, and within 1 mile of the Atlantic coast was changed from May 1 and June 7 to April 1 and June 30 based upon MD spawning survey data .
		2004	Crabs harvested from the bait industry can by bled by the biomedical industry. These crabs must be returned to the bait harvester after being bled.
		2009 Continue	April catch or harvest restriction was added to the spring fishery. MD COMAR 08.02.10.01.01 states that HSCs cannot be caught or landed in MD state waters from December 1 to June 7. This restriction includes a May 1 to June7 closure. Scientific collection permits (including biomedical bleeding) allow HSC

1994 Chesapeake Bay and Atlantic Coast Horseshoe Crab Management Plan Implementation Table (updated 3/2014)			
Problem Area	**Action**	**Date**	**Comments**
			collection during the fishery closure so long as crabs are released alive within 48 hours to waters where they were caught. HSCs are collected and reared as part of the education outreach program entitled "Green Eggs and Sand."
		On-going	June 8 to July 10 harvest is allowed 1 mile off Maryland's Atlantic coast. Harvest is allowed in all tidal waters from July 13 to November 30. Harvest is Monday through Friday and female harvest is prohibited.
	1.2b Virginia will continue its ban on trawling within state waters.	1995	Virginia prohibits the use of trawls in Virginia's portion of the Territorial Sea.
	1.3 Virginia will prohibit a directed horseshoe crab fishery between May 1 and June 7, continue mandatory reporting in the conch dredge fishery and monitor bycatch of horseshoe crabs.	1995	An ASMFC HSC FMP was adopted in 1998. Since then, additional harvest restrictions have been implemented as needed.
Strategy 2.1 Maryland and Virginia will coordinate with Delaware and begin to develop a spawning stock census of horseshoe crabs that will serve as the basis for determining management recommendations as appropriate.	2.1 Maryland and Virginia will coordinate and implement a horseshoe crab spawning stock census in Chesapeake Bay, coastal bays, and along the Atlantic coast.	1995	An annual spawning stock survey was initiated from 1994 to 2000 in MD. The Delaware spawning survey provides data on assessing the status of the spawning population. MD's spawning survey is only in the coastal bays (not the Chesapeake Bay). MD Coastal Bays HSC trawl survey has been conducted since 1990.
		2002 Continue	Maryland Coastal Bays program began a volunteer spawning survey. Public reports of HSC spawning in Chesapeake Bay are kept on file.
		2007 Continue	Adaptive Resource Management Modeling (ARM) is being used to determine the ecological interaction between HSCs and shorebirds, and the economic and biological value of HSCs to the commercial fishery and the biomedical industry.
		2008 Continue	Biomedical industry is collaborating with USFWS Coast wide Tagging Program for HSC.
	2.2 Maryland and Virginia will promote and encourage research on horseshoe crab estimates of population abundance, age and size composition, mortality estimates and migration.	Open	Continue to participate in the annual HSC meeting of regional biologists and managers. A University of Maryland Eastern Shore project to determine if a spawning stock survey could be used to provide a statistically significant index of abundance was partially funded. CPUE data is collected from MD's offshore and coastal bay trawl survey, and blue crab summer trawl survey within the Chesapeake Bay. Sex data is collected from MD's spawning beach survey. A tagging program was initiated in 1995 to determine migratory patterns, identify stocks, and increase our understanding of the HSCs spawning behavior. USFWS currently directs the effort.
		On-going	ASMFC coastal management actions include a mandatory monitoring program, tagging studies, spawning surveys, and egg surveys.
3.1 Maryland and	3.1a Maryland will require horseshoe crab harvesters to	1995	Reporting was implemented on January 29th, 1996. Permit system currently

1994 Chesapeake Bay and Atlantic Coast Horseshoe Crab Management Plan Implementation Table (updated 3/2014)			
Problem Area	**Action**	**Date**	**Comments**
Virginia will monitor the commercial and medical harvest of horseshoe crabs to improve the quality of data obtained from the commercial fishery.	provide monthly reports on the size of harvest, area of collection, gear usage, and any other information the Department of Natural Resources deems necessary.	Continue	required and used to monitor commercial harvest.
		2000	ASMFC instituted a 25% reduction in horseshoe crab bait landings using 1995-1997 as the reference period.
		2004	MD has implemented additional restrictions based on ASMFC Addendum III.
		On-going	MD landings limited to 170,653 lbs annually based on 2001 landings.
		2005	MD began implementing a 1:1 male:female harvest ratio issued by public notice. Saturday and Sunday harvest closure. Limit of 100/person/day with permit 1 mile off Atlantic Coast from Jun 8 to Jul 10. From Jul 13 thru Nov 30 in all waters, harvest is quota on permit or 25/person/day without permit. Permittee's catch limit based on ratio of reported 1996 landings applied to total annual allowable landings for the present year.
		2006	ASMFC Addendum IV changed start of harvest closure from May 1 to January 1. This provision was to expire in 2008 but was continued through 2009. All HSC supplied to the bait fishery is included in that states allowable harvest. Biomedical industry will make available all HSC that die prior to live release to the bait fishery.
		2004	HSC annual bait fishery quota has been 170,653 HSCs since 2004**.** Harvest
		Continue	closure was Dec 1 – March 31 and May 1 - June 7. Harvest is allowed >1 mile offshore during April 1 – 30 & June 8 - 30. Harvest is allowed from July 1 – Nov 30 in all MD tidal waters.
		2008	MD changed the HSC harvest ratio to 2:1 male:female ratio (issued by public notice**)**.
		2009	Biomedical industry is allowed to land male HSCs for bleeding during the May
		Continue	1 to June 7 harvest closure so long as the crabs are released within 48 hours. Spring harvest closure was extended to include April 30. A "chain of custody" must be documented for every batch of HSCs received.
		2010	Harvesters are required to submit monthly catch logs. Commercial harvest
		On-going	reports must be submitted to MDNR Fisheries Service within 10 days after the end of the month being reported after which the report is late.
		2011	Harvesters have begun to import Asian horseshoe crabs for bait market.
		2013	**Maryland banned the importation of Asian horseshoe crabs.**
	3.1b Maryland will determine if a special permit to harvest horseshoe crabs is necessary after evaluating the new federal reporting system and the results of the	1995	MD requires a special HSC permit to land HSCs.
		2001	ASMFC allows state-to-state transfer of quotas.

1994 Chesapeake Bay and Atlantic Coast Horseshoe Crab Management Plan Implementation Table (updated 3/2014)			
Problem Area	**Action**	**Date**	**Comments**
	monthly reports	On-going	
	3.2 Virginia will continue their mandatory reporting procedures implemented in January 1993.	1993 Continue 2000 2006	Reporting was implemented in January of 1993. VA has a commercial quota based on coastal reference period. ASMFC instituted a 25% reduction in horseshoe crab bait landings using 1995 to 1997 as the reference period. ASMFC Addendum IV changed the start of harvest closure from May 1 to January 1 through 2008. It required that Virginia trawl harvest not exceed a certain percentage from a specified area and must maintain at least a 2:1 male:female harvest ratio to protect the Delaware stock. Commercial quota is 152,495 HSCs. Quota can be transferred from other jurisdictions with a combined cap.
	3.3 Maryland and Virginia will survey American eel harvesters and their use of horseshoe crabs by sex for bait.	1995 2000	No longer an issue. Both eels and horseshoe crabs are managed through ASMFC coastal FMPs.
4.1.1 The jurisdictions will define and protect horseshoe crab spawning areas that are used by migrating shorebirds.	4.1 Maryland and Virginia will initiate a study to delineate the geographic distribution of horseshoe crab spawning habitat in the Chesapeake Bay and coastal bays if funding is available.	Open Continue	A HSC hotline and spawning beach survey was developed in 1994 to delineate spawning habitat in Maryland. The survey is available through the MDNR website. VA has also established a hotline. MD DNR Coastal Bays Program and Worcester County staff have cooperative projects that display shoreline stabilization using soft shoreline designs to create or protect HSC spawning habitat.
	4.2 The jurisdictions will promote research to define the water quality requirements for horseshoe crabs.	2010 Continue	Maryland Coastal Bay volunteer spawning survey began recording temperatures to understand the horseshoe crab spawning behavior in the Maryland Coastal Bays.
	4.3 The jurisdictions will continue to work with the Chesapeake Bay Program, the Coastal Bay Initiative, and water quality improvement goals for the Bay and coastal areas.	Continue	The Chesapeake 2000 agreement commits to improving habitat and water quality for living resources in the Bay. The Comprehensive Coastal Management Plan (CCMP) includes strategies and actions to improve Coastal Bays water quality and habitat conditions.

Acronyms

ASMFC- Atlantic States Marine Fisheries Commission
CBP - Chesapeake Bay Program
COMAR - Code of Maryland Regulations
CPUE - Catch per Unit Effort
FMP - Fishery Management Plan
HSC - Horseshoe Crab
MDNR – Maryland Department of Natural Resources
NMFS – National Marine Fisheries Service
USFWS - US Fish and Wildlife Service
VAC - Code of Virginia